MODEL STUDIES OF APRA HARBOR GUAM, M. I.

PROGRESS REPORT for MARCH, 1948

CALIFORNIA INSTITUTE OF TECHNOLOGY
Hydrodynamics Laboratories
Operating Under
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NAVY DEPARTMENT
BUREAU OF YARDS AND DOCKS

MODEL STUDIES
of
APRA HARBOR, GUAM, M.I.

PROGRESS REPORT
for
MARCH 1948

HYDRODYNAMICS LABORATORIES
HYDRAULIC STRUCTURES DIVISION
of the

CALIFORNIA INSTITUTE OF TECHNOLOGY
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I INTRODUCTION

The data presented in the February report were analyzed further during the month of March. This analysis, guided by BuDock's letter of 4 December 1947, Budock's dispatch of 3 March 1948, and a conference with the OinCC or the contract, resulted in comparisons of shoal effects on the basis of averaging the disturbances in the repair basin areas designated for primary use. This average facilitates the comparison of the effectiveness of the different protective structures, since each average characterizes the performance of each given structural configuration under a given imposed ocean condition.

Experimentation was started on photography to record induced current movements within the harbor. Attempts are being made to adapt the equipment available to the taking of pictures in the daytime rather than during the late evening and early morning hours found necessary for the Pasadena model.

The wave height measuring unit which gave a great deal of trouble in the latter part of February was thoroughly reconditioned during the analysis period to reduce delays which might otherwise arise during the running of future tests.

Photographers for "Life" magazine spent one day taking pictures of the model and the laboratory. Visitors during the month included the OinCC of the Contract and Capt. Baumer, BuDocks Public Works Officer at the Long Beach Naval Shipyard.

II SCOPE OF THIS REPORT

This report involves principally a reanalysis of the data used as the basis of the February report. The reason for the reanalysis is to present comparisons of shoal effects based on arithmetic averages of disturbances in important areas within the repair basin. The nine shoal structures of the twelve shoal and breakwater structures used in the February report, are again compared but with selected combinations of oscillograph array readings serving as the basis of the comparison. In other words, the same data are resubmitted but now rearranged to give proper weighting to each oscillograph array station in accordance with its relative importance to the primary usage of the repair basin.

III COMPARISON OF PERFORMANCE CHARTS AND DISCUSSION OF NINE SHOAL STRUCTURES

As a continuation of the data presented in the report for February there are enclosed here Tables 1, 2, and 3 and Plates 1, 2, and 3. The original data utilized for the charts and tables have been used before; as indicated in Sections I and II, they are given here, however, in a different arrangement. The oscillograph array stations have been grouped to represent three separate areas. This grouping was agreed upon at a conference on 24 March attended by the OinCC of the contract, Capt. Baumer, the Public Works Officer for the Bureau at Long Beach Naval Shipyard, and the laboratory staff members. Accordingly, for purposes of comparison, the readings from stations 6, 14, 20, and 22 have been grouped together and are considered to be representative of the primary usage of the repair basin. These stations are located as follows: #6 at the carrier base, #14 in the center of the north shore of the basin, #20 in the center of the south shore, and #22 at what has previously been called the tanker berth but is now known as IJ Docks. Similarly, those from stations 16 and 18 have been combined and are considered to be representative of the east shore of the repair basin, being located in the northern and southern half of the east shore respectively, while the readings from station 12 are considered as indicative of the southwest end of Army Port Facilities. For the time being, the recordings from station 3 in the inner harbor at the south end of the channel from the repair basin are not included in the comparisons because only slight variations in disturbances have been observed at this station with the nine different shoal structures under the four ocean conditions.

The structures used in this month's comparison are listed below for convenience. All are under Harbor Development Plan #2.

Shoals JSW (JSW = Jade, Southern, Western)

Shoals JSW Mod. (Mod. = channels filled)

Shoals JSW Mod. and Closed North Channel

Shoals JSW Mod. and APF Mod. (APF = Army Port Facilities)

Shoals JSW and APF Mod.

Shoals JSW Mod. and DDI Mod. (DDI = Dry Dock Island)

Shoals JSW and DDI

DDI Only

No Shoals

Plates 1, 2, and 3 show whether a given structure performs better or worse than each of the other eight structures under any of the four ocean conditions. The values used for the comparisons represent the averages of the maximum wave heights for the repair basin (stations 6, 14, 20, and 22), for the east shore of the repair basin (station 16 and 18) and for the southwest end of Army Port Facilities (station 12). The data upon which the comparisons are based were previously presented in Section IV of the report for February 1948.

The results of Harbor Development Plan No. 1, to which group the breakwaters previously studied belong, are not included in these comparisons because the array stations are not considered as being in comparable locations within the repair basin area nor in the area along the east shore of the repair basin for the two plans.

Table 1 and Plate 1 show the comparative effect of each of the nine shoal structures based upon arithmetic averages of four array stations located at areas designated for primary use in the repair

basin. Table 2 and Plate 2 represent the comparative effect of the nine structures for the east side of the repair basin based upon arithmetic averages of two array stations located along the east shore; Table 3 and Plate 3 are those for the southwest end of Army Port Facilities.

IV CONCLUSIONS

Verification runs are under way at present and until these have been completed the following conclusions must be considered tentative only.

When the average maximum disturbances in the repair basin for all four ocean conditions are considered it may be seen from Table 1 that the three best shoal structures in order of decreasing quality are: Shoals JSW Mod. and DDI Mod., Shoals JSW Mod., and Shoals JSW.

While Shoals JSW Mod. and DDI Mod. give the best protection to the repair basin, it is seen from Table 1 that the next five shoal combinations cause disturbances only 25 to 50 percent worse. The two structures No Shoals and DDI Only allow disturbances 8 to 9 times as great as those present with the protection of Shoals JSW Mod. and DDI Mod.

In considering the average maximum disturbances at the east side of the repair basin for the four ocean conditions it may be seen that the best protection is again offered by the structure Shoals JSW Mod. and DDI Mod. Shoals JSW and DDI are second with Shoals JSW Mod. third. However, these last two protective combinations permit disturbances more than 50 per cent worse than the best structure. Again the two structures No Shoals and DDI Only allow disturbances many times as great as those present with the protection of Shoals JSW Mod. and DDI Mod.

At the southwest end of Army Port Facilities, the structure Shoals JSW and Closed North Channel gives the best protection, as would be expected. Three others, nevertheless, show disturbances only 20 to 30 percent worse. Although one would not expect the structure Shoals

JSW Mod. and DDI Mod. to perform favorably in this location, the disturbance is only 75 percent worse.

Another manner of comparison would be to use No Shoals as a basis. If this is done, the structure Shoals JSW Mod. and DDI Mod. reduces the disturbances not only in the repair basin but also along its east side to less than one-eighth that present with the shoals dredged to -45 ft.

A few verification runs have yet to be made and until such time as completed the above conclusions are to be considered tentative.

TABLE I

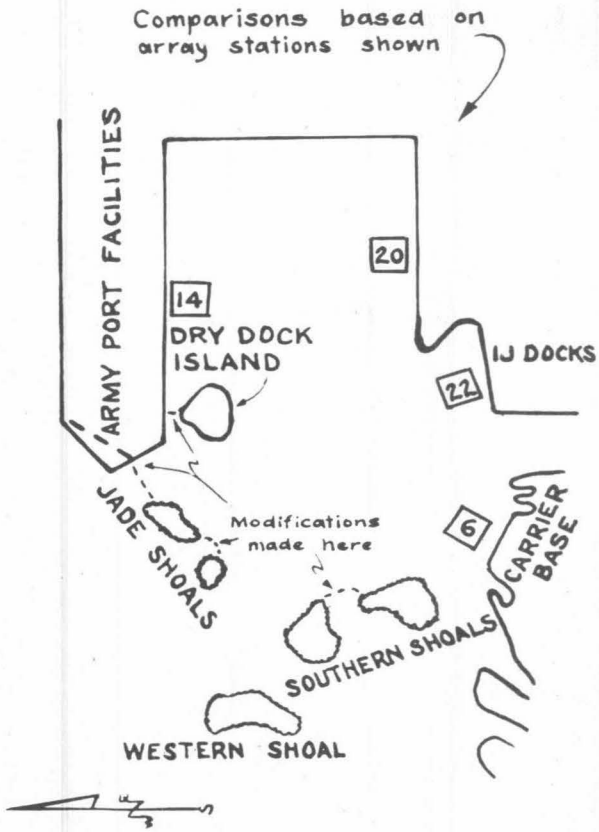
REPAIR BASIN

Tentative Quantitative Ratings of the
Effects of Nine Shoal Structures for Westerly
Waves 600 and 1200 ft. Long at
MLLW and MHHW

Structure	Max. disturbances in percent of imposed wave height				Ave.	Percent Worse than JSW Mod. and DDI Mod.
	MLLW		MHHW			
	600	1200	600	1200		
1. JSW Mod. and DDI Mod.	3.3	4.7	3.8	5.1	4.2	-
2. JSW Mod.	4.4	4.3	4.5	7.6	5.2	25
3. JSW Mod. and Cl. No. Ch.	4.8	4.8	6.6	5.6	5.4	30
4. JSW	6.1	4.1	6.2	6.2	5.6	35
5. JSW and DDI	4.6	6.0	6.0	6.6	5.8	40
6. JSW and APF Mod.	6.8	5.4	5.2	7.4	6.2	50
7. JSW Mod. and APF Mod.	5.4	6.7	7.4	8.0	6.9	70
8. No Shoals	33.2	30.9	30.2	36.3	32.6	680
9. DDI Only	38.6	38.5	41.8	42.5	40.4	860

STATIONS		WAVE LNGTH	TIDES	1	2	3	4	5	6	7	8	9
1	SHOALS JSW	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
2	SHOALS JSW MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
3	SHOALS JSW MOD AND CLOSED NO. CHANNEL	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
4	SHOALS JSW MOD AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
5	SHOALS JSW AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
6	SHOALS JSW MOD AND DDI MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
7	SHOALS JSW AND DDI	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
8	DDI ONLY	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
9	NO SHOALS	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									

NOTE - Shading indicates better ordinate than abscissa at MLLW ▨ or at MHHW ⁘



COMPARATIVE EFFECTIVENESS OF VARIOUS STRUCTURES IN REPAIR BASIN

AGAINST
30' W 600' & 1200' WAVES
AT MLLW & MHHW

DATE 3/31/48 PLATE-1

TABLE II

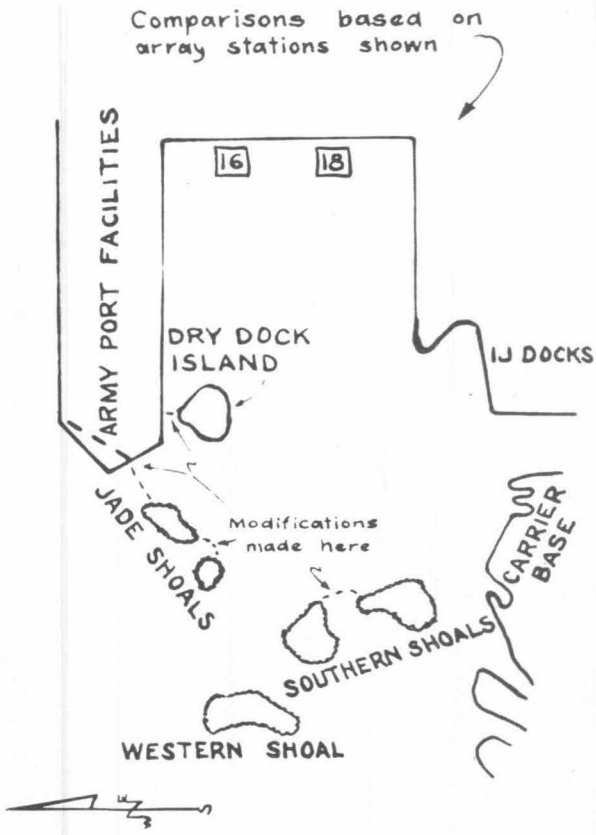
EASTSIDE OF REPAIR BASIN

Tentative Quantitative Ratings of the
Effects of Nine Shoal Structures for Westerly
Waves 600 and 1200 ft. Long at
MLLW and MHHW

Structure	Max. disturbances in percent of imposed wave height				Ave.	Percent Worse than JSW Mod. and DDI Mod.
	MLLW		MHHW			
	600	1200	600	1200		
1. JSW Mod. and DDI Mod.	3.0	4.6	3.8	3.7	3.8	-
2. JSW and DDI	6.3	5.4	6.7	6.7	6.3	65
3. JSW Mod.	5.9	5.9	5.8	7.8	6.4	70
4. JSW and APF Mod.	6.0	7.2	5.6	7.4	6.6	75
5. JSW Mod. and Cl. No. Ch.	5.4	6.8	7.1	7.4	6.7	75
6. JSW	8.5	5.2	6.2	8.0	7.0	85
7. JSW Mod. and APF Mod.	5.9	8.4	7.8	7.6	7.4	95
8. No Shoals	29.4	37.7	28.3	34.8	32.6	760
9. DDI Only	36.5	49.2	28.8	34.6	37.2	880

	STATIONS	WAVE LNGTH	TIDES	1	2	3	4	5	6	7	8	9
1	SHOALS JSW	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
2	SHOALS JSW MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
3	SHOALS JSW MOD AND CLOSED NO. CHANNEL	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
4	SHOALS JSW MOD AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
5	SHOALS JSW AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
6	SHOALS JSW MOD AND DDI MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
7	SHOALS JSW AND DDI	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
8	DDI ONLY	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
9	NO SHOALS	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									

NOTE - Shading indicates better ordinate than abscissa at MLLW ▨ or at MHHW ⁘



COMPARATIVE EFFECTIVENESS OF VARIOUS STRUCTURES AT THE EAST SHORE OF REPAIR BASIN

AGAINST
30' W 600' & 1200' WAVES
AT MLLW & MHHW

DATE 3/31/48 PLATE-2

TABLE III

TIP OF ARMY PORT FACILITIES

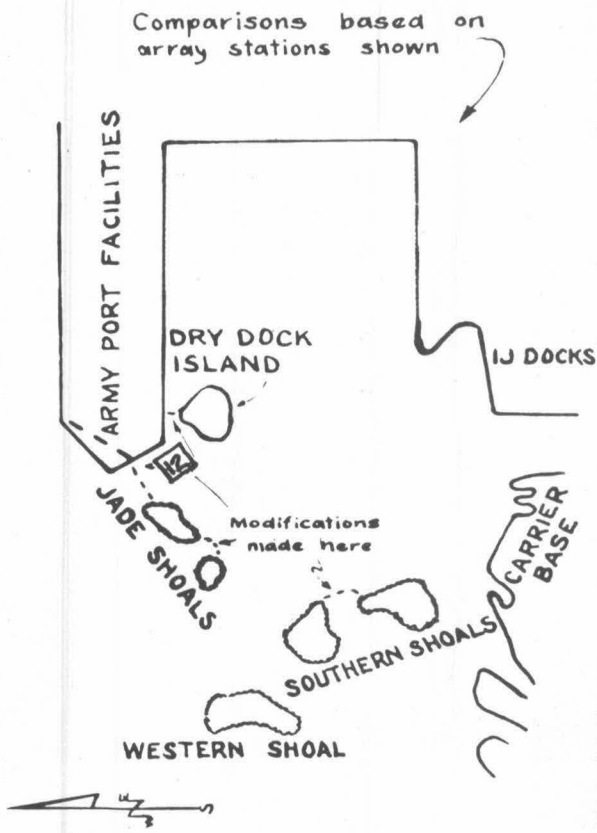
Tentative Quantitative Ratings of the
Effects of Nine Shoal Structures for Westerly
Waves 600 and 1200 ft. Long at
MLLW and MHHW

Structure	Max. disturbances in percent of imposed wave height				Ave.	Percent Worse than JSW Mod. and Cl. No. Ch.
	MLLW		MHHW			
	600	1200	600	1200		
1. JSW Mod. and Cl. No. Ch.	6.2	7.4	7.1	13.6	8.6	-
2. JSW Mod.	11.9	7.4	9.5	13.0	10.5	20
3. JSW and APF Mod.	12.0	10.5	8.7	12.0	10.8	25
4. JSW Mod. and APF Mod.	7.4	11.3	12.4	13.9	11.2	30
5. JSW	18.5	11.8	9.8	14.5	13.6	60
6. JSW Mod. and DDI Mod.	15.1	15.4	13.6	16.9	15.2	75
7. JSW and DDI	16.7	10.2	22.1	-	18.7*	120*
8. No Shoals	34.2	32.7	37.7	25.4	32.5	280
9. DDI Only	52.0	49.7	29.4	40.3	42.8	400

*Estimated

STATIONS		WAVE LNGTH	TIDES	1	2	3	4	5	6	7	8	9
1	SHOALS JSW	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
2	SHOALS JSW MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
3	SHOALS JSW MOD AND CLOSED NO. CHANNEL	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
4	SHOALS JSW MOD AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
5	SHOALS JSW AND APF MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
6	SHOALS JSW MOD AND DDI MOD	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
7	SHOALS JSW AND DDI	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
8	DDI ONLY	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									
9	NO SHOALS	600	MLLW									
			MHHW									
		1200	MLLW									
			MHHW									

NOTE - Shading indicates better ordinate than abscissa at MLLW or at MHHW



COMPARATIVE EFFECTIVENESS OF VARIOUS STRUCTURES AT THE SOUTHWEST END ARMY PORT FACILITIES

AGAINST
30' W 600' & 1200' WAVES
AT MLLW & MHHW

DATE 3/31/48 PLATE-3

V MISCELLANEOUS

A. Current Studies

Experimentation with photographs of reflectors was begun during the month. In order to study the flow of ocean and tidal currents, or of induced currents, it is proposed to distribute reflecting floats over the water areas under consideration, as was done in the Pasadena model. The path of the floats will then be recorded photographically by multiple exposures on the same negative. In order to accomplish this with the aerial cameras available, it is necessary to prevent the transport of the film between exposures and to keep the shutter open as long as desired. Both aerial cameras have already been modified to hold the film stationary. Another problem involved is that of lighting; further development along this line is necessary and will be carried on whenever time permits.

B. Wave Height Measuring Unit

Advantage was taken of the reanalysis period to recondition completely the wave height measuring unit which caused considerable trouble in the latter part of February. The oscillator now provides better adjustment over a wider range of sensitivity ratios than was heretofore permissible. The seventeen galvanometer elements used in the instrument plus the four spare elements were returned to the Pasadena factory for repair, rebalancing and testing. This is the first time these elements have been reconditioned since delivery of the instrument over 18 months ago.

C. Publicity

LIFE magazine photographers spent the entire day of 25 March taking pictures of the laboratory, the model and its appurtenances. The photographs and text have been sent to Washington to be cleared for early publication in the magazine.